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ABSTRACT

The effect of a self-instructional (SI) training paradigm on the arithmetic deficits of orthopedically handicapped children and the degree to which training effects generalize to the classroom and to another arithmetic function were studied. The study consisted of two experiments, each conducted with three orthopedically handicapped students with deficits in addition without regrouping. The first experiment involved primary students; the second experiment, intermediate students. The author concludes that SI was an effective procedure for remediating arithmetic deficits of orthopedically handicapped students and that SI effects generalize to the classroom. (MK)

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Final Report:

Self-Instructional Training: A Resource Strategy for Arithmetic Deficits

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August, 1979

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INTRODUCTION

The purpose of this study was threefold:

1. To determine the effect of a self-instructional (SI) training paradigm on the arithmetic deficits of orthopedically handicapped children.
2. To assess the degree to which training effects generalize to the classroom.
3. To assess the degree to which training effects generalize to another arithmetic function.

The statements that individuals make to themselves, whether overt or covert, about a task they must perform have long been recognized as a critical factor in the actual performance of the task. However, until recently little was known about how such statements could be used to improve performance. Meichenbaum and Goodman (1971) demonstrated a procedure that effectively faded self-instructions from an overt to a covert form, and resulted in improvements in the task at which the self-instructions were directed. In addition to being effective with situation on content specific tasks, review of SI literature (Meichenbaum, 1977) indicates a number of investigations that reported significant generalization across behaviors and settings.

A study by Leon and Pepe (1978) found that an SI training strategy used to remediate arithmetic deficits with learning disabled and educable mentally handicapped students resulted in significant improvements in the computational skills serving as target behaviors. In addition, they reported data that served as a basis for suggesting that students generalized the SI strategy to other problems with similar computational concerns. A major suggestion for further research from the Leon and Pepe (1978) study was

the investigation of whether SI training generalized across arithmetic functions, i.e., does SI training with additional skills result in improvement in subtraction skills?

For educators working with exceptional students a priority issue is whether training conducted outside the classroom generalizes to the classroom. Several SI studies directed at attending (Bornstein and Quevillon, 1976) and social (Kurtz, Rocke, Hanson and Neisworth, 1976) skills reported that SI training conducted outside the classroom resulted in improvement in the target behavior in the classroom settings. Similar findings with academic skills would enhance the potential to the SI approach as an alternative strategy for remediating academic deficits.

In the present study two experiments were conducted. Experiment I was concerned with whether SI was an effective procedure for remediating arithmetic deficits in addition without regrouping, and whether any gains noted in the training setting generalized to the student's classroom. Experiment II assessed the effectiveness of SI training as a remediation strategy for arithmetic deficits in addition without regrouping. Experiment II also assessed the degree to which the training affected performance in subtraction without regrouping.

The SI paradign used was based on that of Meichenbaum and Goodman (1971) (see Appendix A), and modified by Leon and Pepe (1978) for use with arithmetic (see Appendix B). In addition to the self-instructional statements, the package included coping and reinforcing statements.

EXPERIMENT I

Subjects

Three primary level, orthopedically handicapped students served as subjects in this experiment. Each student was exposed to the SI training on a daily basis. Training sessions were 15 minutes in length and were conducted in a room adjacent to the classroom by a student trainer.

Design and Procedure

The Key Math Diagnostic Arithmetic Test (KMDAT) (Connolly, Natchunan and Pritchett, 1971) was administered to each subject on a pre, post basis. The results of the pre-test provided a global indication of the subjects' functioning level in mathematics, and an indication of where to begin SI training. The posttest provided an indication of the effects of SI across mathematics areas contained in the test.

The design used in this study was a multiple baseline across subjects. This design allowed for the determination of the effect of the SI training and intersubject replication of the effect. In addition, weekly probes were administered by the classroom teacher. The weekly probes served as a measure of generalization across settings. Following the completion of the SI training maintenance probes were carried out to determine whether any gains resulting from training maintained over time.

Results

Table I contains the results of the pre and post administrations of the Key Math Diagnostic Arithmetic Test. The difference between pre and post test scores indicated an increase in raw score of 27 points or 44.74% for Tom, 17 points or 32.08% for Jane, and 6 points or 13.95% for Dick. On the

Grade Equivalency scale the improvement in raw score resulted in an increase grade level of 1.1 for Tom, .6 for Jane, and .3 for Dick.

TABLE I

Results of Pre and Post Testing
With the Key Math Diagnostic
Arithmetic Test -- Experiment I

	Pre		Post		Gain	
	Raw Score	Grade Level	Raw Score	Grade Level	Raw Score	Grade Level
Tom	38	1.1	65	2.2	27	1.1
Jane	53	1.7	70	2.3	17	.6
Dick	43	1.3	49	1.6	6	.3

Figure I presents the results obtained across the three conditions of the experiment for each of the students. During baseline the mean level of performance was for Tom 20%, Dick 3% and Jane 8.93%. Probes of arithmetic performance in the classroom were comparable to those of obtained in the training setting, with only one probe beyond 30%.

Data collected in the training setting during the SI phase was used as a measure of performance, and to determine movement through the SI sequence. These data were not a true indicator of computational skill and therefore were included in Figure 1. Probe data from the classroom during SI training indicated increased percentages of problems correct for Tom (90 & 80%) and Jane (80 & 50%). Tom and Jane completed SI training in 13 and 11 days respectively.

The results of classroom probes indicated no improvement in computation for Dick following three weeks of SI training. Similarly, the student trainer indicated that Dick had not yet reached criterion at the third level of SI training (overt self-instruction). On the 27th day of the experiment the content of the SI training was changed to basic addition facts. After three weeks SI training for addition without regrouping was reinstituted. The classroom probe during the final week of SI training resulted in an increase to 30% for problems computed correctly.

Starting with the third day following SI training, three consecutive posttests were administered to Tom. The percentage of problems correct on the posttests were 80, 90, and 100%. On the 56th through 62nd days of the experiment, and beginning 45 days after completion of SI training a series of six consecutive follow-up tests were given. The results of the follow-up tests ranged between 80 and 100%, with a mean of 91.66%, a mean increase of 71.66% over the baseline mean of 20%.

Percentage correct on a posttest administered to Dick two days after completion of SI training was 90%. A series of six consecutive follow-up tests were administered beginning on the ninth day following training. The results of the follow-up test ranged between 60 and 100%, with a mean of 78.33%, resulting in a mean increase of 70.33% over the baseline mean of 8.03%.

A series of six consecutive posttests were given to Jane beginning on the fifth day after completion of SI training. The results ranged between 50 and 70% correct with a mean of 58.33% resulting in a mean increase of 55.33% over the baseline mean of 3%.

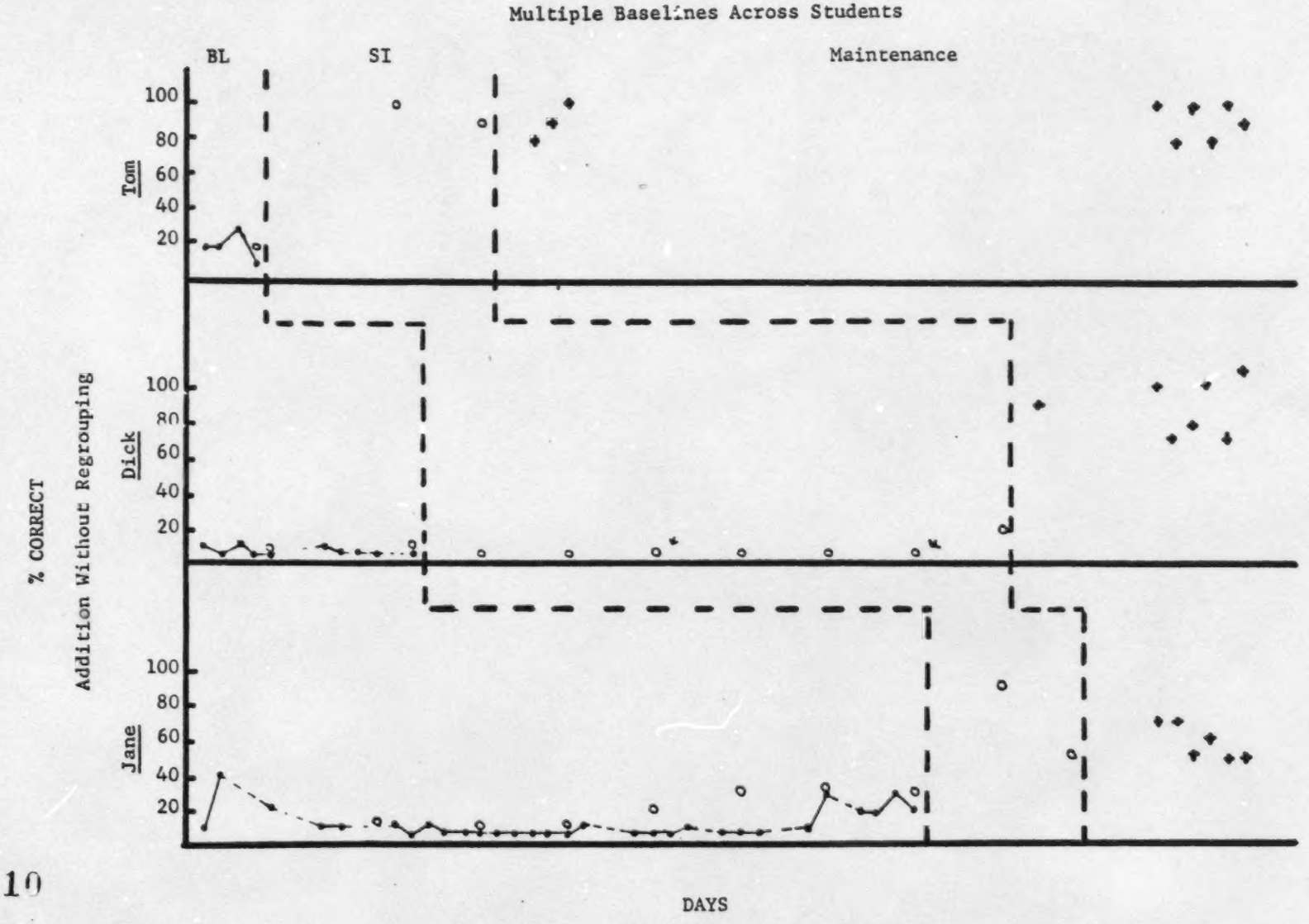

Fig. 1. Percentage of problems correct across students. Solid data points (•) indicate performance in Training Setting, unfilled data points (o) indicate probes in classroom, and crosses (+) maintenance probes.

EXPERIMENT II

Subjects

Three intermediate level, orthopedically handicapped students served as subjects in this experiment. Training sessions were conducted by a student assistant on a daily basis in a room adjacent to the classroom.

Design and Procedure

The KMDAT was administered to each subject on a pre, post basis. The results of the pre-test provided a global indication of the subject's functioning level in mathematics, and an indication of where to begin SI training. The posttest provided an indication of the effects of SI across mathematics areas contained in the test. The design of Experiment II was a modified baseline across arithmetic functions. This design allowed for the determination of the effect of SI training, as well as the degree to which any improvements on the trained function generalized to a second function. A seried of posttests were administered to determine performance on both the trained and untrained arithmetic functions.

Results

Table 2 contains the results of the pre and post tests for the KMDAT. The difference between pre and post tests raw scores was 22 points, or 31.88% for Bill, 13 points, or 16.45% for Ben, and 17 points, or 21.52% for Bob. On the Grade Equivalency Scale the improvement in raw score resulted in an increase in grade level of .6 for Bill, .6 for Ben and .4 for Bob.

TABLE II

Results of Pre and Post Testing

With the Key Math Diagnostic

Arithmetic Test -- Experiment II

	Pre		Post		Gain	
	Raw Score	Grade Level	Raw Score	Grade Level	Raw Score	Grade Level
Bill	69	2.3	91	2.9	22	.6
Bob	79	2.6	92	3.0	13	.4
Ben	79	2.6	96	3.2	17	.6

Figures 2, 3 and 4 presents the results obtained across the modified multiple baseline for the functions of addition with regrouping and subtraction without regrouping for Bill, Ben and Bob, respectively. During baseline Bill's mean scores were 25% for addition with regrouping and 43.75% for subtraction without regrouping. After completion of 15 days SI training for addition with regrouping, a series of five posttests were administered. The score on the posttests indicated a mean increase of 63% for addition with regrouping, and 24.25% for subtraction without regrouping.

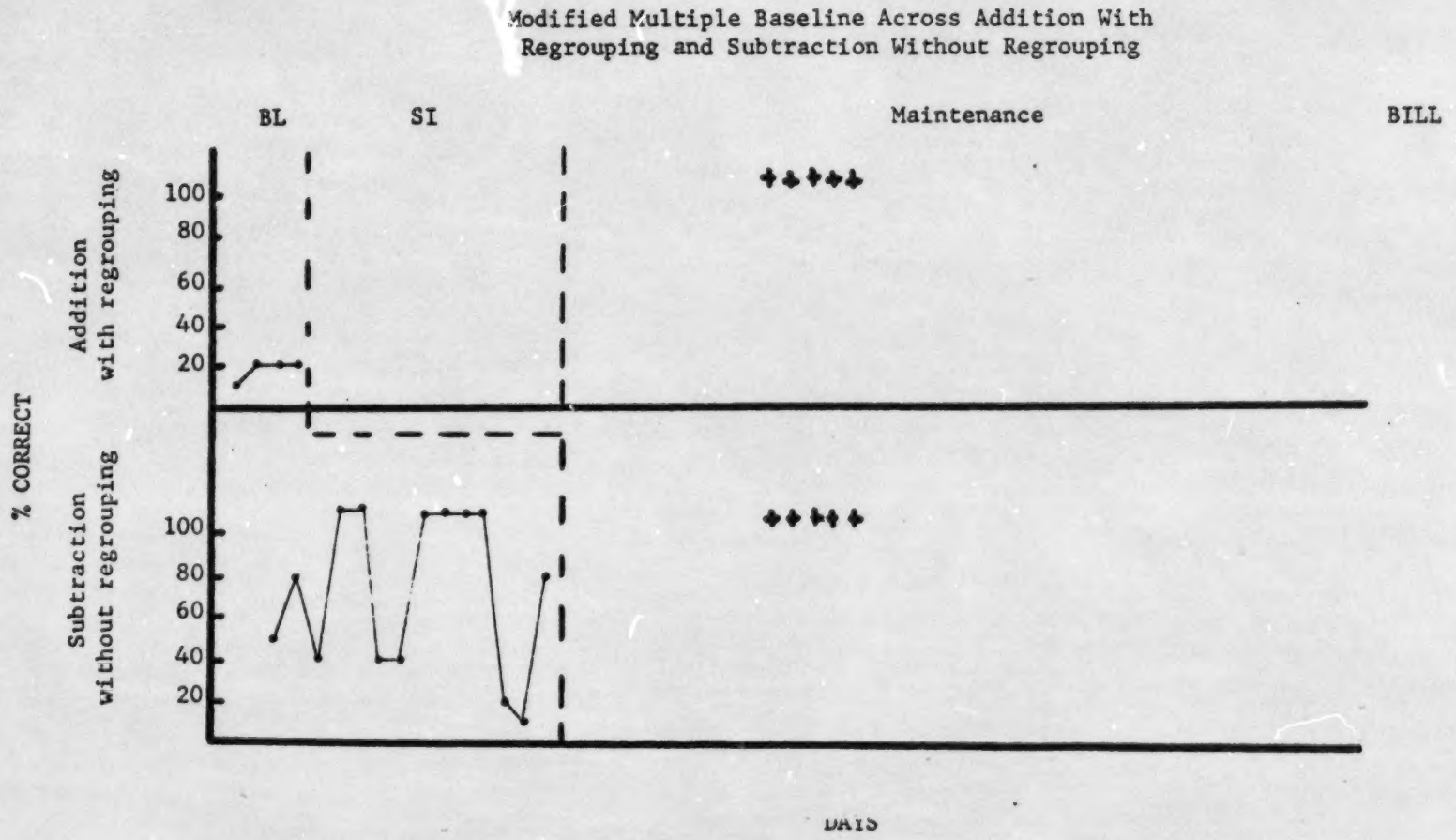

Fig. 2. Percentage of problems correct across arithmetic function. Solid data points (•) indicate performance in training setting, crosses (+) indicate maintenance probes.

During baseline Bob's mean scores for addition with regrouping and subtraction without regrouping were 30 and 41.66% respectively. After completion of 11 days of SI training for addition with regrouping a series of five posttests were administered. The results of posttesting indicated a mean increases of 66% for addition with regrouping, and 26.34% for subtraction without regrouping.

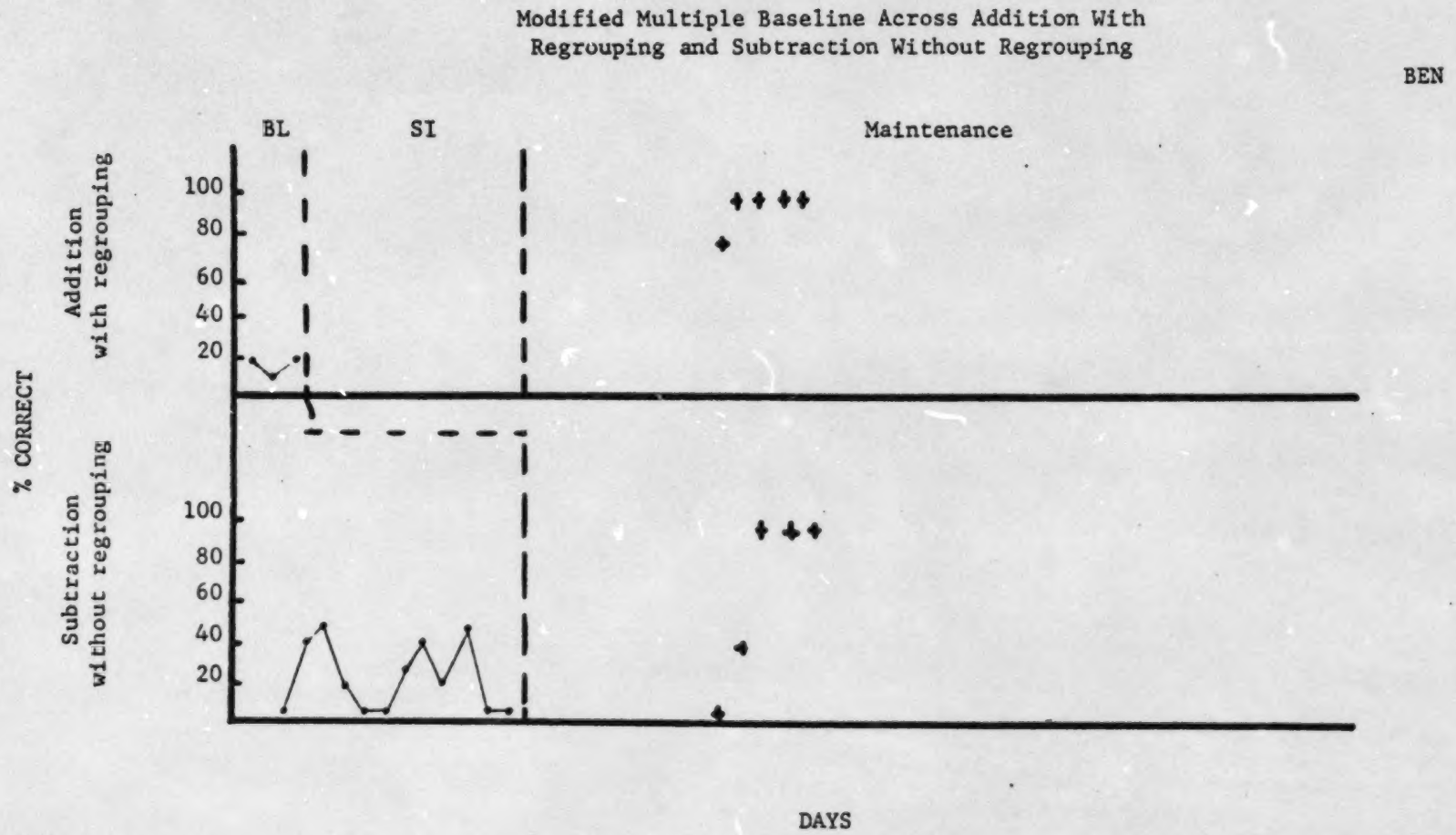

Fig. 3. Percentage of problems correct across arithmetic function. Solid data points (·) indicate performance in training setting, crosses (+) indicate maintenance probes.

During baseline Ben's mean scores for addition with regrouping and subtraction without regrouping were 15 and 34.60% respectively. After completion of 12 days of SI training for addition with regrouping a series of five posttests were administered. The results of posttesting indicated a mean increase of 84.4% for addition with regrouping and 65.4% for subtraction without regrouping.

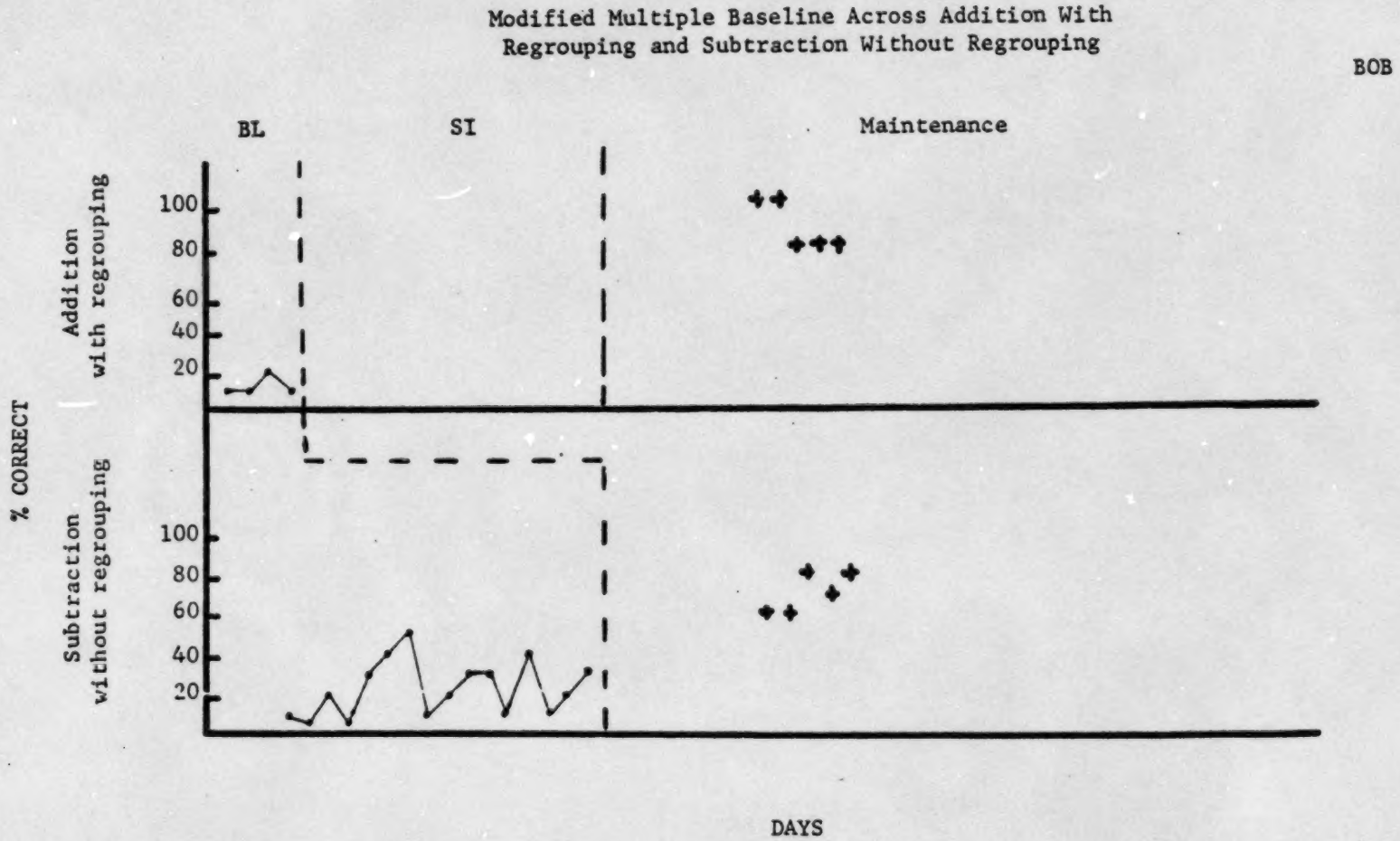

Fig. 4. Percentage of problems correct across arithmetic function. Solid data points (•) indicate performance in training setting, crosses (+) indicate maintenance probes.

DISCUSSION

There are several conclusions that can be drawn from this study. The first is that SI was an effective technique for remediating deficits in the type of computation exposed to training in both Experiment I and II. The results of the KMDAT (Tables 1 and 2) indicate that each of the students demonstrated gains in raw score, and that the least amount of improvement in grade level (.3 grades) by any student was approximately equal to a normal rate of learning, or growth in mathematics. This conclusion is further supported by analysis of the ideographic data (Figures 1, 2, 3 and 4). Comparison of posttests to baseline for each student indicates that the least amount of improvement made by any of the students in the computational area exposed to SI was 55%.

Imbedded in this conclusion, and the data upon which it is based is a second point of significance. Previous research using SI with arithmetic (Leon and Pepe, 1978) incorporated a curriculum containing at least six modules for each area of computation, and provided SI training for each module. In the present study the SI strategy and dialogues were adapted so as to be applicable to any problem within a computation area, regardless of the number of columns involved. This finding may be particularly significant since Leon and Pepe (1978) concluded that in comparison to traditional approaches to remediation the SI approach required greater amounts of time.

A major area of concern in the present study was to assess the amount of generalization, across both settings and computational domains, associated with SI. Regarding generalization across settings, analysis of the probe data from Experiment I (Figure 1) indicates that Tom's performance in the classroom during SI training improved, while Dick and Jane who remained in the baseline

condition during the same period of time did not show corresponding improvement in the classroom. Within the framework or rationale of Applied Behavior Analysis these results provide a basis for concluding that the effects of SI training generalize across settings.

The second area of generalization assessed in this study was domain generalization. As an experimental question it can be specified as, "Does SI training in addition with regrouping effect computation of subtraction problems without regrouping?" Although the results of Experiment II (Figures 2, 3 and 4) reflect improvement in the student's ability to compute both addition with regrouping and subtraction without regrouping, it is not possible to draw a clear conclusion as to why this occurred. It is possible to suggest several possible causes for the improvement. Analysis of student performance during baseline indicates that skill in computing subtraction problems was in their behavioral repertoires, but not at a mastery level. At posttesting, however, all three students showed high levels of percent correct, with minimal variance in performance from day-to-day. Within the constraints of the present study it is possible to suggest that the results were a function of SI, or simply a practice effect, and is a topic for further research.

In summary, the following conclusions are possible, based on the results of the study:

1. SI was an effective procedure for remediating arithmetic deficits of orthopedically handicapped students.
2. The effects of SI generalized from the training setting to the classroom.
3. Although improvement in a second, untreated arithmetic function occurred, it is not possible to conclude why the improvement occurred.

DISSEMINATION

The present research has been accepted, and will be presented at the Fall Conference, Illinois Council of Teachers of Mathematics. In addition, the research has been submitted to the Illinois Council of Exceptional Children for possible presentation at the annual conference.

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Appendix A

Self-Instructional Paradigm

SI PARADIGM

Level I - Observation of a model performing the task using overt self-instructions.

Level II - Trainer and client performing the task together using overt self-instructions.

Level III - Client performs task using overt self-instructions.

Level IV - Client performs task using whispered self-instructions.

Level V - Client performs task using covert self-instructions.

Appendix B

Self-Instructional Paradigm

Modified for Arithmetic

(Dialogues)

Dialogue: Addition Without Regrouping

Problem:

$$\begin{array}{r} 6 \\ +\ 2 \\ \hline \end{array} \qquad \begin{array}{r} 46 \\ +\ 32 \\ \hline \end{array}$$

Question: What is the first thing I have to do?

Answer: Find the sign. O.K. This means I have to add.

Question: How do I add?

Answer: I start with the 6. I add it to the 2, that makes 8.

Question: What do I do now?

Answer: I write 8 at the bottom of the column.

Question: Is there only one column?

Answer: Yes, then the answer is 8 and the problem is finished.

or

Question: Is there more than one column?

Answer: Yes.

Question: What do I do?

Answer: I start with the 4. I add it to the 3. That makes 7.

Question: What do I do now?

Answer: Write 7 at the bottom of the column. The answer is 78.

Student receives feedback that the answer is correct.

Dialogue: Addition with Regrouping

Problem:
$$\begin{array}{r} 33 \\ +\ 7 \\ \hline \end{array}$$

Question: What do I have to do?

Answer: Find the sign. [illegible] This sign means add.

Question: How do I add?

Answer: I start with the 3. I add it to 7. That makes 10.

Question: What do I do now?

Answer: I write 0 at the bottom of the column. Then I write 1 above the 3.

Question: What do I do now?

Answer: I add the 3 to the 1, that's 4.

Question: What do I do with the 4?

Answer: I write 4 at the bottom of the column.

Question: Am I finished?

Answer: There are no more numbers, so I'm finished and the answer is 40.

Student receives feedback that the answer is correct.